

PATENT SPECIFICATION

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(54) DEWATERING DEVICES

(71) We, CHARLES WALKER CONSOLIDATED LIMITED, a British Company of Beta Works, Leeds, LS1 4DG, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in the following statement:-

This invention relates to dewatering devices particularly useful in the paper, board and asbestos cement industries.

In modern papermaking machinery, such as modern fourdrinier machines, refined pulp suspension, or stock, is passed on an endless mesh conveyor, the "wire", over various devices for removing water until the web is coherent enough to be passed onto a felt conveyor for final drying. The devices for removing water comprise those which assist the paper-making by their shape, e.g. foil blades or forming board tops and those which act in conjunction with suction, e.g. suction box tops. The latter are positioned immediately under the wire, covering the vacuum boxes, and have holes or slots made in them in patterns designed to extract the desired amount of water.

All of the dewatering devices bear against the underside of the wire and so their physical characteristics such as hardness, abrasion resistance and coefficient of friction are of great importance in determining their working lives and the life of the wire. The wire, in particular is expensive in itself and in the down-time during which the machine is out of action while it is being replaced. Traditional forming box tops have been made from hardwood such as end of grain maple, but modern practice favours certain plastics materials such as high molecular weight, high density polyethylene which has a very low coefficient of friction and can be machined with woodworking equipment. However, high density polyethylene, although an improvement over maple, could

still be improved in abrasion resistance, particularly at leading edges and surfaces subjected to the greatest wear.

It has been proposed to provide wear inserts, e.g. of ceramic material or tungsten carbide, but these give rise to other problems. Firstly, such inserts are brittle and difficult to handle; they cannot generally be machined with the normal tools used in making dewatering devices and so must be fitted extremely accurately; they are expensive; and finally their hardness can lead to excessive wear on the wire.

The invention seeks to overcome the disadvantages of prior proposals by providing a composite having extremely hard-wearing and abrasion resistant working surfaces which nevertheless have a low coefficient of friction and do not abrade the wire, and are not affected by the conditions operative in papermaking.

According to the present invention there is provided a dewatering device for use with paper, board and asbestos making machinery which comprises working surfaces, part only of which have wear inserts of polyurethane material cast *in situ*.

Preferably the working surfaces comprise high density polyethylene. The wear inserts should extend substantially across the full width of the device, but on hydrofoil blades should not form more than part of the working surfaces in the direction of travel of the wire.

The dewatering device may be formed as a hydrofoil blade, suction box top, forming board top or the like.

Conveniently a high density polyethylene blank has a recess machined in the position where the wear insert is required, the ends of the recess are blocked off and a polyurethane precursor is poured into the recess flush with the surface of the blank. After curing, the blank/polyurethane composite is machined to its final required

configuration. It has been found that a composite produced in this manner has exceptionally desirable properties. The relative expansion characteristics of the polyethylene and the polyurethane are such that there is a clamping action on the wear insert, even though the polyethylene is a relase agent and is very difficult to adhere. Accordingly the composite can be machined to its final shape as a whole, and there is no problem of the wear insert becoming loose or buckling in use.

The invention further provides a method of making a dewatering device for use with paper, board and asbestos making machinery whcih comprises providing a blank, forming one or more recesses in the blank, casting a polyurethane precursor in the recess or recesses and, optionally, machining the composite so-formed into its final shape.

According to the invention there is also provided paper, board and asbestos making machinery containing such a composite article.

We have found that polyurethane has a number of desirable characteristics for use as a wear surface under a Fourdrinier wire. However these very characteristics, e.g. toughness and flexibility, make it extremely difficult to machine, and, if it is moulded, accurate and expensive moulds are necessary. Further, foil blades and the like composed of polyurethane would be too flexible in use and would tend to deform or vibrate thus reducing their efficiency as dewatering devices. Further, polyurethane is relatively expensive and the cost of polyurethane foil blades would be excessive. The composite article of the invention combines the toughness and flexibility of polyurethane at the areas where it is most required with the rigidity and ease of machining of polyethylene, thus giving a composite which is superior to equivalent devices made out of either material alone. Further, the improved rigidity imparted to the polyurethane by being held in a polyethylene matrix enables the composite to be machined to acceptable standards with normally available tools, and expensive moulds or tools are not required.

While the above discussion has been concerned largely with composites in which the main body has been made of high density polyethylene, any other rigid and easily formable material having the requisite thermal and chemical properties desired for use in the forming section of a paper making machine may be used. Similarly, the composite article may have three or more components, e.g. the working surfaces may be mounted on a metal base.

Polyurethane wear inserts, being extremely tough yet resilient, have very desirable mechanical characterisits for use in hydrofoil blades and the like. However, it

has been found that certain types of polyurethane do not have the chemical resistance to the conditions extant at the forming section of a paper-making machine, and cracks can develop causing damage to the wire. Accordingly, we prefer to select polyether-based polyurethanes with relatively long alkyl chains between the ether linkages to give maximum resistance to degradation in use.

The polyurethane precursor referred to above is a mixture of reactants which will combine, or "cure", into a solid polyurethane resin, whether by the action of heat, catalysis or effluxion of time.

The polyurethanes used in the invention are elastomeric polyether polyurethanes and more particularly may be made from isocyanate capped long chain polyoxyalkylene glycols suitably cured as discussed more fully hereinafter.

The polyoxyalkylene glycols may be capped with simple aromatic or aliphatic diisocyanates such as hexamethylene diisocyanate (HMDI) or tolylene diisocyanate (TDI).

The best results are produced with straight chain polyether backbones, and poly-tetra-methylene oxide chain backbones are preferred. A TDI capped version of the latter is particularly preferred, and a product of this type is commercially available under the trademark "Adiprene" (Du Pont).

The polyurethane precursors may be cured with, for instance, polyamines or polyols but it is preferred to avoid moisture curing since carbon dioxide is liberated and this may cause bubbles or occlusions in the product.

Suitable polyols include diols and triols, and compounds such as 1,4 - Butane diol and trimethylol propane may be used. It is preferred to include at least some triol to promote cross-linking since the diol cures the resin chiefly by chain-extension.

However, for many purposes it is preferred to cure the urethane with polyamines such as diamines. Aliphatic or aromatic diamines may be used although the latter are preferred. Suitable diamines include methylene dianiline, m-phenylene diamine and, especially 4,4 -methylene-bis - (2-chloro aniline) or blends of such diamines. The latter is available commercially under the trademark "Moca" (Du Pont).

As is known in the art, catalysts, fillers, pigments and the like can be incorporated into the polyurethane mix to impart desired properties. Further, materials which lower the friction of the product may be added, e.g. PTFE, graphite, silicone fluid or polyethylene powder.

The polyurethanes of the composite of the invention have excellent hardness and abra-

sion properties; and preferably have Shore hardness values within the range 80°A to 80°D, particularly in the range 93 to 96°A.

As mentioned previously the base of the composite is preferably made from high density polyethylene. A preferred form had an average molecular weight in the region of $2 \text{ to } 4 \times 10^6$, preferably $3.5 \text{ to } 4 \times 10^6$ measured by the light scattering method. This may be produced by the Zeigler low pressure polymerisation process. Preferred polyethylene is available under the tradename Betadur (Lunds of Bingley). The polyethylene material will generally have a greater hardness value on the Shore scale than the polyurethane, and so wear inserts of the latter are less damaging to the wire.

However, owing to the fact that the portions of the surfaces subjected to most wear are made from polyurethane, lower grades of polyethylene, including low density or reused polyethylene, may be used for the main body portions if desired, thus producing a cost saving.

The composites of the invention may be formed as dewatering devices such as hydrofoil blades, forming board tops, doctor blades or the like, or as the tops of suction or vacuum boxes where they operate with the aid of externally applied suction. For dewatering devices such as foil blades the polyurethane portions should be wear inserts only, the remainder of the wear surfaces being the main body material, e.g. polyethylene. However, for suction box tops, where the conditions of operation are slightly different, it may sometimes be desirable for the whole of the surface in contact with the Fourdrinier wire to be composed of polyurethane. However the working surface, i.e. in this case the top surface, as before is not wholly composed of polyurethane, there being suction holes, slots or the like in the surface and bridging pieces of the main body material.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view through a hydrofoil blade constructed according to the invention;

Figure 2 is a similar view of a blank form which the blade of Figure 1 is formed; and

Figure 3 is a perspective view of a suction box top constructed according to the invention.

Referring to figures 1 and 2, a rectangular block 10 of high density polyethylene, Betadur, has a recess 12 machined into it. The ends of the block are blocked off with metal endplates (not shown) screwed to the block 10 at either end of the recess. A polyurethane precursor mixture 14 is poured into the recess 12 until it is flush with the top surface of the block 10. After the

polyurethane has cured the composite is machined to the shape shown in figure 1 in which the leading section 16 comprises a polyurethane wear insert 18 and the wear surfaces 20 and 22 are part polyurethane and part polyethylene respectively. A further recess 24 is formed in the base of the composite to enable it to be mounted on a papermaking machine. The arrow A indicates the direction of travel of the wire across the working surfaces.

Figure 3 illustrates a suction box top constructed in a similar manner, and like numerals indicate like parts. A high density polyethylene base 10 has dovetailed recesses 12 machined into it and the ends blocked off as before. A polyurethane precursor is cast *in situ* flush with the top surface of the block 10 in each of the recesses forming wear inserts 18. After curing, the end plates are removed and the ends trimmed. At this point the polyethylene portions are machined to produce suction slots 26 separated from each other by bridge pieces 28. The top surface is machined smooth giving polyurethane wear surfaces 20 and polyethylene surfaces 22. The bridge pieces 28 are machined down to a level below the plane of the surfaces 20, 22. If desired for certain applications, the polyethylene surfaces 22 may also be machined below the level of the polyurethane wear surfaces 20. Even the latter case the working surface of the suction box top, i.e. the whole top surface, is still composed only partly of polyurethane. The suction box cover so formed is positioned on a vacuum box immediately below the wire in a Fourdrinier-type paper-making machine, and the working surface contacts the wire in use.

In order to illustrate the invention further the following example is given.

EXAMPLE:

A high density polyethylene suction box top $15\frac{1}{2}$ feet long is machined with grooves similar to grooves 12 in figure 3. Corresponding wear inserts 18 are formed of polyurethane as follows:

100 parts of 'Adiprene L 167' is heated to between 80 and 85°C in a vessel together with $\frac{1}{2}$ part of pigment green C13. 19.5 parts of 'Moca' is melted between 110°C and 115°C, added to the vessel and stirred for one minute after which the mix is cast into the recesses 12. After a time of 15 or 20 minutes the polyurethane is cured at 100°C for 2 hours and the composite is allowed to cool. The composite is then machined as described above in relation to Figure 3 to give suction slots 26 and smooth wear surfaces 20, 22.

The suction box cover formed of the composite of the invention was found to perform better than currently available materials in

that wire wear was reduced, and cover wear was reduced.

WHAT WE CLAIM IS:-

- 5 1. A dewatering device for use with paper, board and asbestos making machinery, which comprises working surfaces, part only of which have wear inserts of polyurethane material cast *in situ*. 55
- 10 2. A device as claimed in claim 1 in which the wear inserts extend across substantially the full width of the article. 60
3. A device as claimed in either of claims 1 or 2 comprising high density polyethylene with polyurethane wear inserts. 65
- 15 4. A device as claimed in any of claims 1 to 3 in which the polyurethane is a polyether polyurethane. 70
5. A device as claimed in claim 4 in which the polyurethane is formed from a TDI capped polytetra- methylene- oxide diol.
- 20 6. A device as claimed in claim 5 in which the polyurethane is cured with a polyamine. 75
- 25 7. A device as claimed in claim 6 in which the polyamine is 4,4 - methylenebis-(2-chloro aniline).
- 30 8. A device as claimed in any of claims 1 to 7 in which the polyurethane contains minor amounts of catalysts, fillers, pigments, or release agents.
- 35 9. A device as claimed in claim 8 in which the release agent is polytetra- fluoroethylene, graphite, silicone fluid or polyethylene powder.
10. A device as claimed in any of claims 1 to 9 being a hydrofoil blade, a forming board top or a suction box top.
- 40 11. A device according to claim 1 substantially as hereinbefore described with reference to and as illustrated in figures 1 and 2 of the accompanying drawings.
- 45 12. A device according to claim 1 substantially as hereinbefore described with reference to and as illustrated in figure 3 of the accompanying drawings and the foregoing Example.
- 50 13. A method of making a dewatering device for use with paper, board and asbestos making machinery, which comprises providing a blank, forming one or more recesses in the blank, casting a polyurethane precursor in the recess or recesses, and, optionally, machining the composite so-formed into its final shape. 55
14. A method as claimed in claim 13 in which the recess or recesses extend substantially across the full width of the blank.
15. A method as claimed in claim 14 in which the ends of the recess or recesses are blocked off with plates fixed to the blank. 60
16. A method as claimed in any of claims 13 to 15 in which the blank is made from high density polyethylene. 65
17. A method as claimed in any of claims 13 to 16 in which polyurethane precursor comprises a mixture of an isocyanate capped polyether diol and a polyamine.
18. A method as claimed in claim 17 in which the polyurethane precursor is mixed at a temperature of from 80 to 115°C and is poured into the recess or recesses. 70
19. A method as claimed in claim 18 in which the blank containing the polyurethane precursor is heated to effect curing of the polyurethane. 75
20. A method as claimed in any of claims 13 to 19 in which the composite is machined into the shape of a hydrofoil blade, a suction box top or a forming board top. 80
21. A method as claimed in claim 13 substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings. 85
22. A method as claimed in claim 13 substantially as hereinbefore described with reference to the foregoing Example.
23. A paper, board or asbestos making machine having a device as claimed in any of claims 1 to 12. 90
24. A suction box top having wear surfaces formed substantially from polyurethane material cast *in situ*. 95

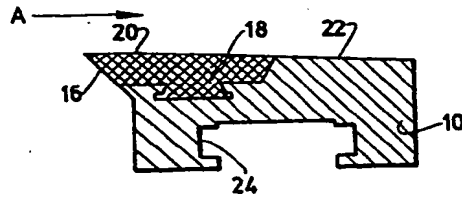
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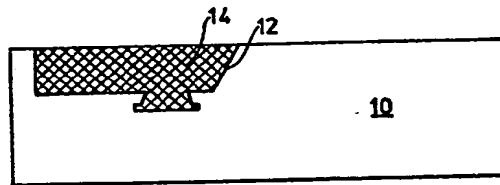
COMPLETE SPECIFICATION

2 SHEETS

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the Original on a reduced scale*
Sheet 1



— FIG. 1 —



— FIG. 2 —

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COMPLETE SPECIFICATION

2 SHEETS

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